

Phosphorus 101: Blue-Green Algae



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Blue-Green Algae

- ❖ Cyanobacteria

- ❖ Differ from other bacteria: photosynthesis

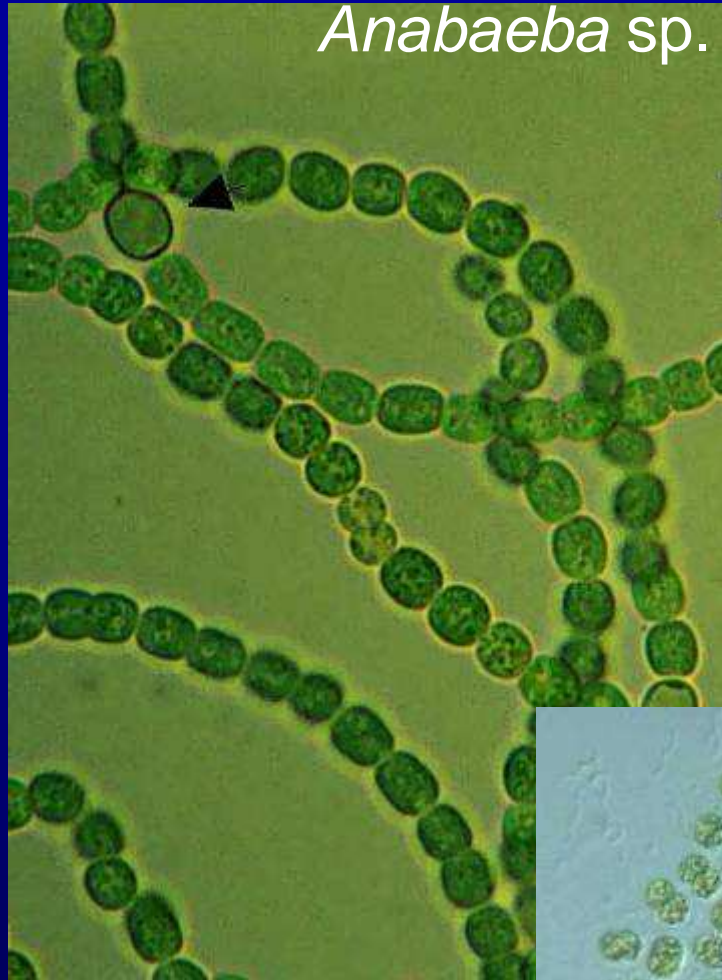
- ❖ Differ from true algae: lack well-defined nucleus

- ❖ Part of the phytoplankton; largely inedible

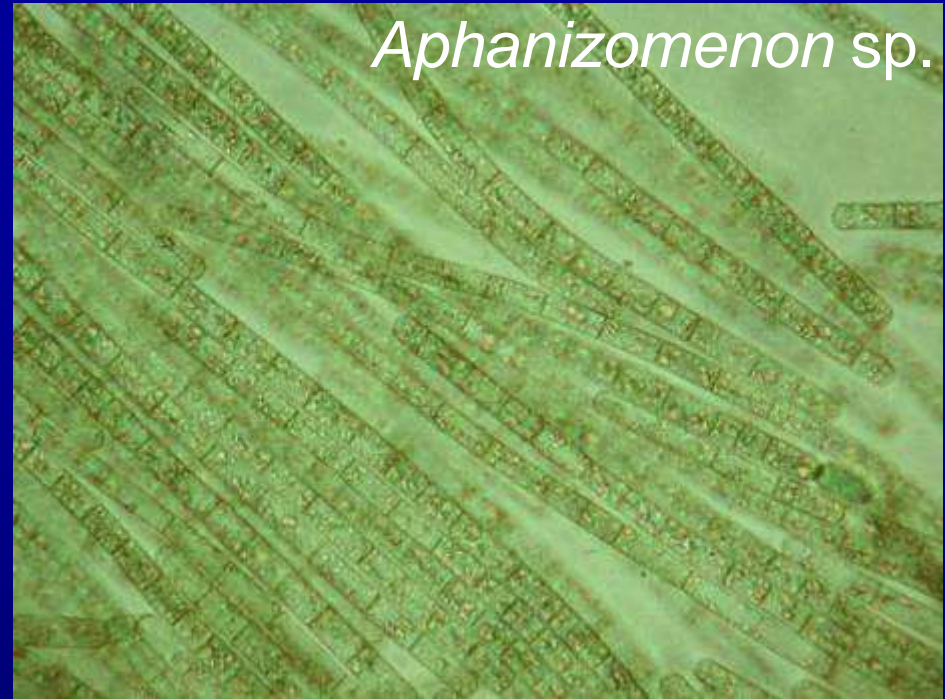
- ❖ Common: *Anabaena*, *Aphanizomenon*, *Microcystis*, *Cylindrospermopsis*, *Planktothrix*, *Lyngbya*



Anabaena sp.



Aphanizomenon sp.



Microcystis sp.



Blue-Green Algae Blooms

- ❖ Nutrients

 - P; some can fix N

- ❖ Temperature

- ❖ Water depth

- ❖ Wind

 - gas-filled vesicles (most)

- ❖ Zebra mussels

 - filter water → sunlight

 - don't eat blue-greens





Issues Associated with Blooms

- ❖ Discolored water
- ❖ Taste and odor
- ❖ Reduced light penetration
- ❖ Dissolved oxygen depletions
- ❖ Toxin production



Blue-Green Algal Toxins

- ❖ Some species produce one or more toxins
- ❖ Toxins not produced at all times
- ❖ Toxins can affect
 - Fish and other aquatic life
 - Livestock
 - Pets
 - Humans (70 deaths in Brazil, 1996; 1 in WI, 2002)



❖ Exposure routes in humans:

- dermal
- oral (water or food)
- inhalation
- dialysis



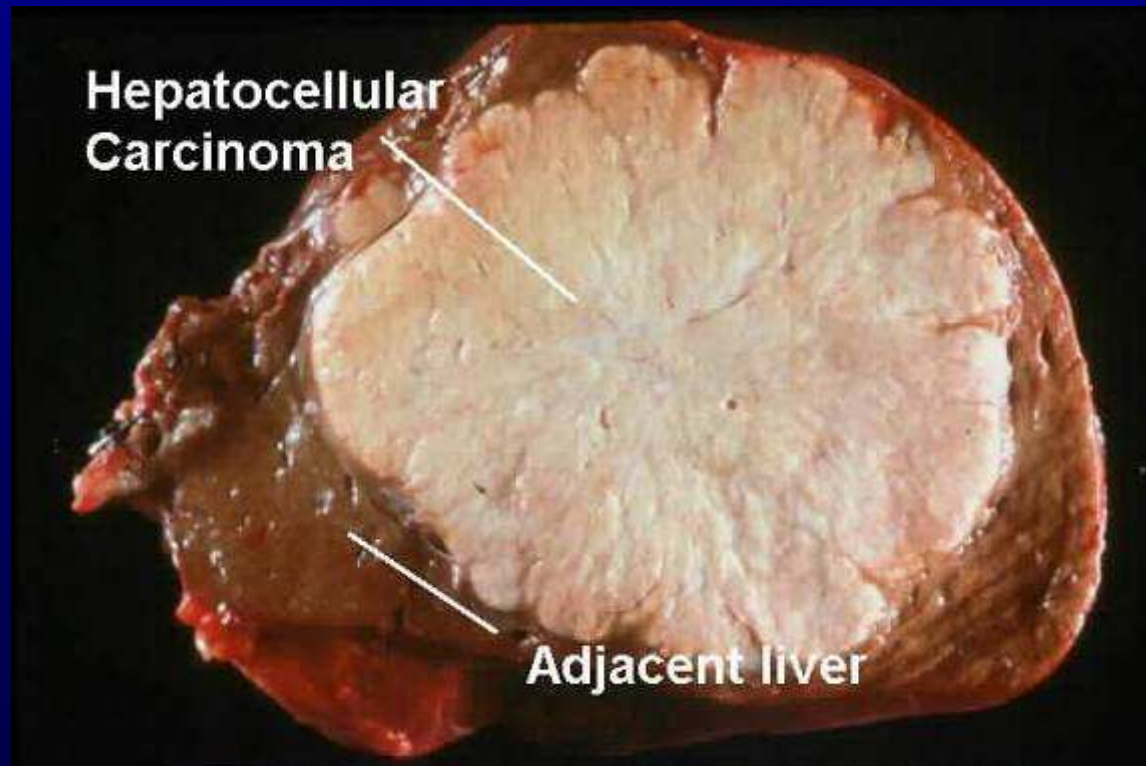
Dermatotoxins and Gastrointestinal Toxins

- ❖ Affect skin and mucous membranes
- ❖ Can cause rashes, respiratory illness, headaches, gastrointestinal upset
 - lyngbyatoxin, lipopolysaccharide endotoxins



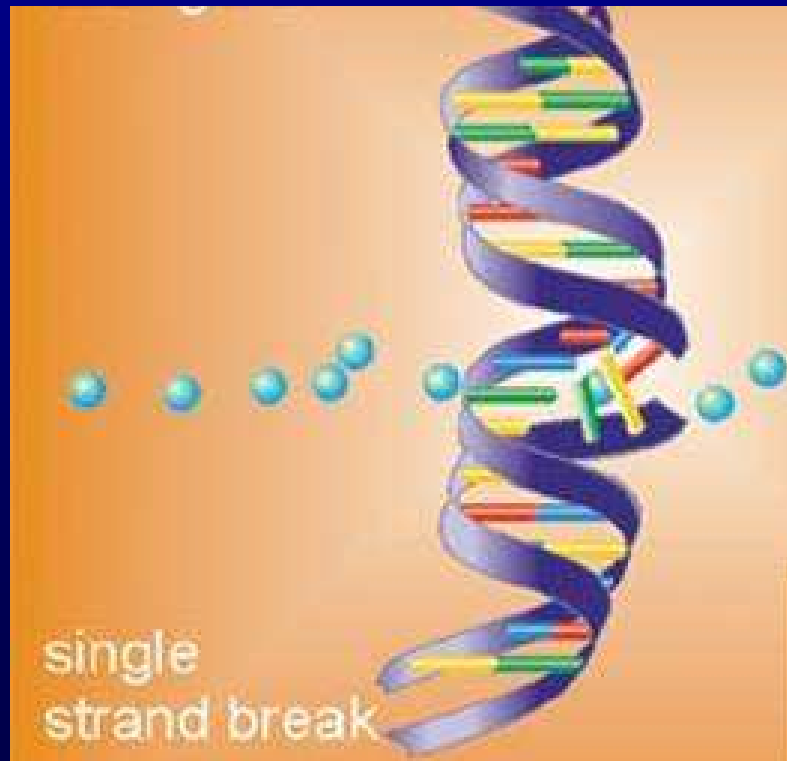
Hepatotoxins

- ❖ Affect the liver (cell membrane integrity)
- ❖ Can cause hemorrhage, tissue damage, tumors, liver cancer, death
 - microcystins, nodularins



Cytotoxins

- ❖ Affect the liver and other organs (protein synthesis)
- ❖ Can cause chromosome loss, DNA strand breakage, damage to organs
 - cylindrospermopsin



Neurotoxins

- ❖ Affect the central nervous system
(acetylcholinesterase, sodium channels)
 - ❖ Can cause seizures, paralysis, respiratory failure, death
- anatoxin-a



“New” Toxins



Lake Mascoma

BMAA (β -N-methylamino-L-alanine)

-neurotoxin

-Chamorro people (Guam); cycad seeds, bats

-freshwater blue-green algae

-linked to Alzheimer's, Parkinson's, and ALS

-in brains of some Alzheimer's patients

-high rate of ALS around lake in NH



Saxitoxin

- paralytic shellfish poison in marine systems
- also produced by some freshwater blue-green algae
- detected in some south central WI lakes
- vomiting, dizziness, numbness, paralysis





Guidelines

- ❖ Currently no surface water quality criteria, no drinking water standards in U.S. for algal toxins
- ❖ World Health Organization guideline of 1 $\mu\text{g}/\text{L}$ microcystin-LR

DNR Blue-Green Algae Monitoring Program

2003-2006

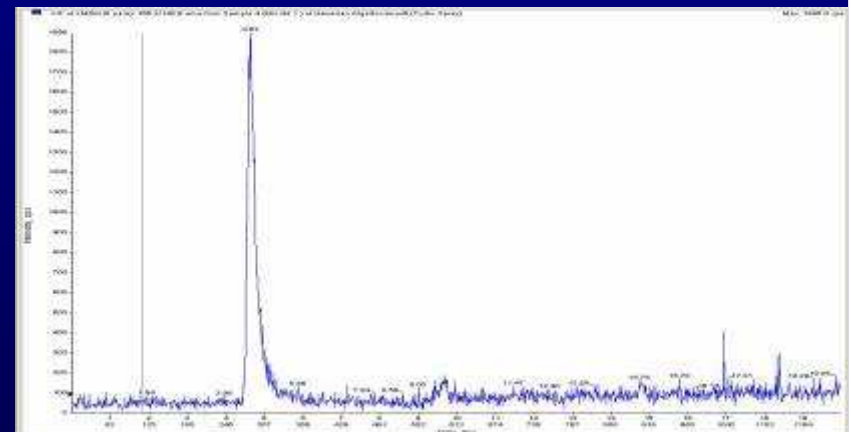
- Limited monitoring conducted statewide
- Blue-green algae, 3 toxins, chlorophyll-a
- Screen vs. counts



- Blue-green algae, and toxins, found in all regions
Hot spots: SCR and WCR
- Even in winter



- Anatoxin-a associated with dog deaths
- Microcystin most common toxin
 - concentrations among highest ever recorded
 - 7,600 $\mu\text{g/L}$! (vs. 1 $\mu\text{g/L}$ WHO value)





- Local public health agencies alerted
- Only the public health agencies have authority to close or post beaches (responses differed)
- Best to avoid any bloom
- Can't predict toxin production

Documenting Blue-Green Algae Blooms

- ❖ Photographs over time
- ❖ Analysis of Chl-a
- ❖ Count and ID algae
 - “Quick screen” by SLOH
 - Cell counts for comparison to WHO guidelines
- ❖ Toxin Analysis
 - Field kits
 - ELISA
 - HPLC/MS/MS



Best: Control nutrients coming in



Thank You